



0.18 μm CMOS Fully Differential CTIA for a 32x16 ROIC for 3D Ladar Imaging Systems

Jirar Helou

Jorge Garcia

Fouad Kiamilev

University of Delaware

Newark, DE

William Lawler

Army Research Laboratory

Adelphi, MD

SPIE 2006, San Diego

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 2006		2. REPORT TYPE		3. DATES COVERED 00-00-2006 to 00-00-2006	
4. TITLE AND SUBTITLE 0.18 &#956;m CMOS Fully Differential CTIA for a 32x16 ROIC for 3D Ladar Imaging Systems				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) University of Delaware, Department of Electrical and Computer Engineering, Newark, DE, 19716				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES Proceedings SPIE Vol. 6294, 629409, Infrared and Photoelectronic Imagers and Detector Devices II; Sep 2006, San Diego, CA					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 19	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

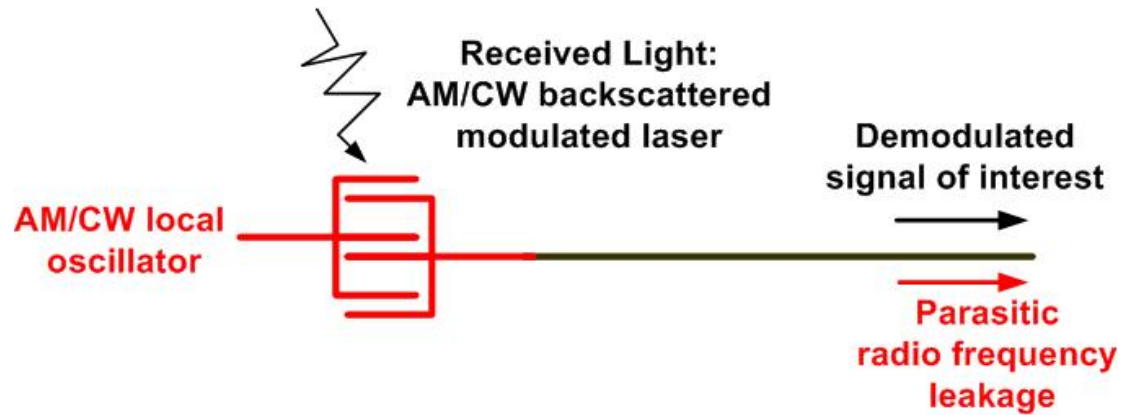


Presentation Outline

- Introduction
 - Photo-detection for AM/CW LADAR using MSM detectors
 - CDMA ROIC architecture
- Fully Differential Channel
 - Differential MSM photo-detector
 - Differential CDS CTIA
 - Mitigation of RF leakage current
- Design Implementation
 - Floor plan and Layout
 - Post-layout Simulation
- Future work
 - Testing methodology



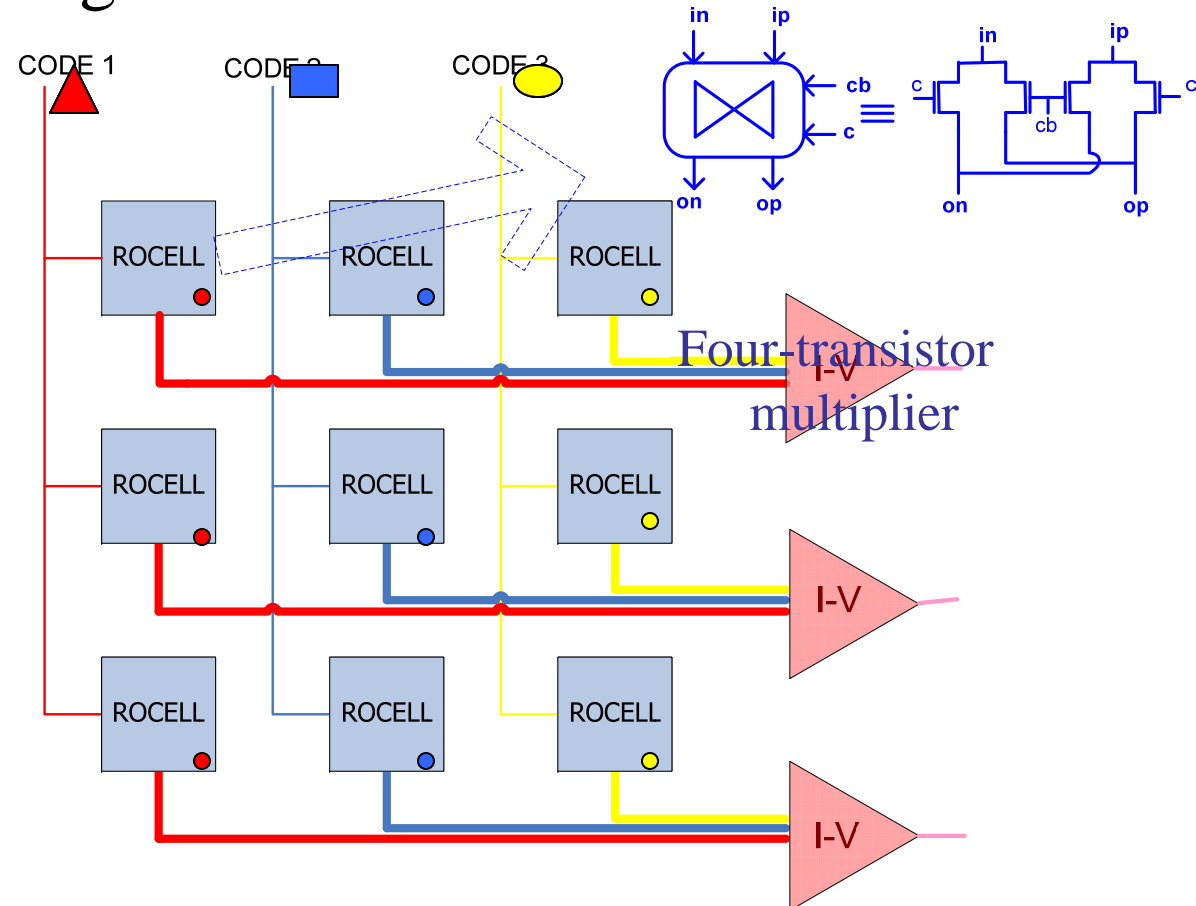
AM/CW Ladar Photo-detection



- RF modulation and demodulation
- Parasitic leakage current
 - Four to five orders of magnitude > signal of interest



Code Division Multiple Access Readout Integrated Circuit Architecture



- Orthogonal sets of codes
- Column-wise encoding



Presentation Outline

- Introduction
 - Photo-detection for AM/CW LADAR using MSM detectors
 - CDMA ROIC architecture
- Fully Differential Channel
 - Differential MSM photo-detector
 - Differential CDS CTIA
 - Mitigation of RF leakage current
- Design Implementation
 - Floor plan and Layout
 - Post-layout Simulation
- Future work
 - Testing methodology

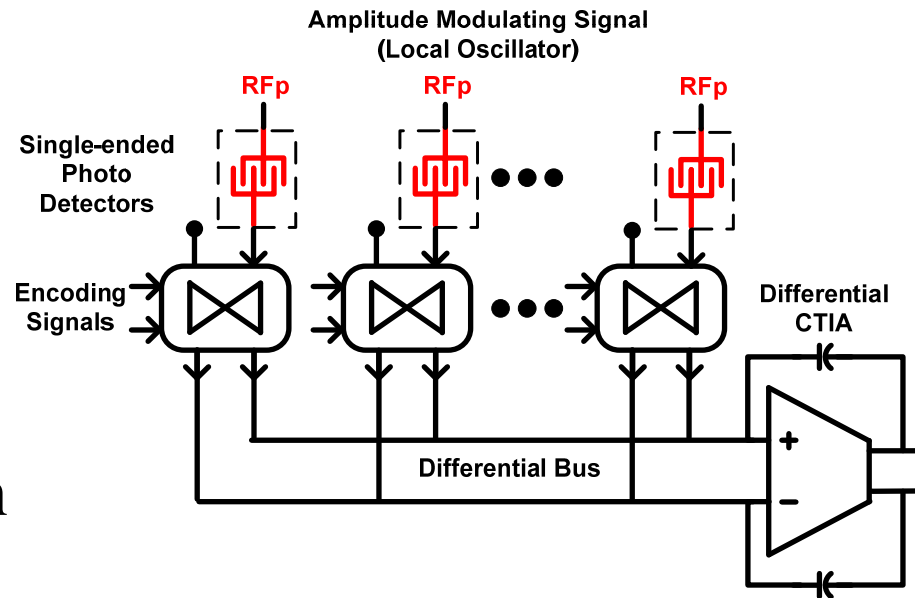


Fully Differential Readout Channel

Single-ended MSM photodetector

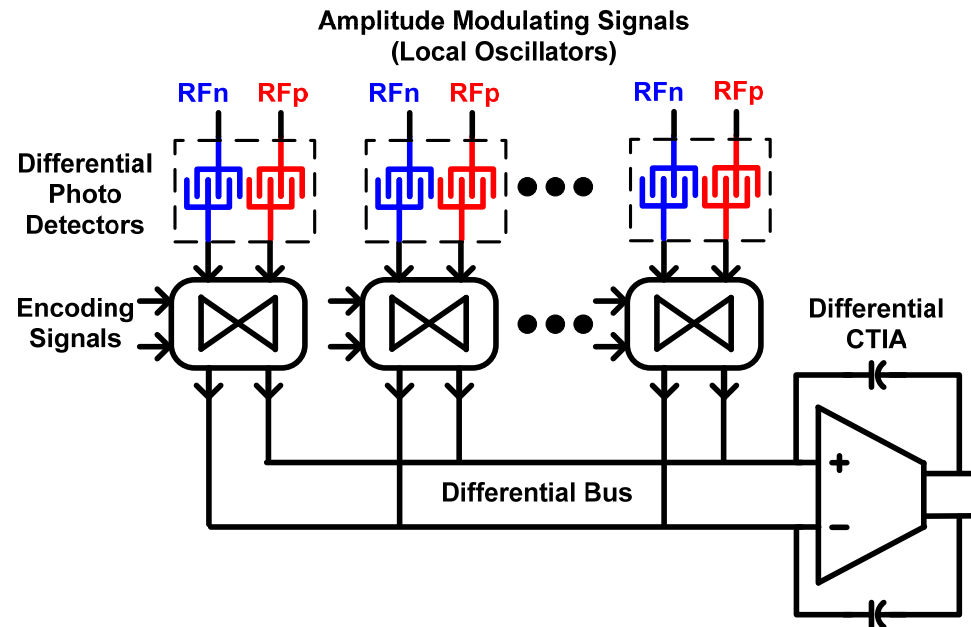


- Disadvantages
 - Not fully Differential architecture
 - Non balanced charged injection in the encoding cell





- Advantages
 - Cancel charge injection imbalance
 - Obtain true and complementary output signals at once



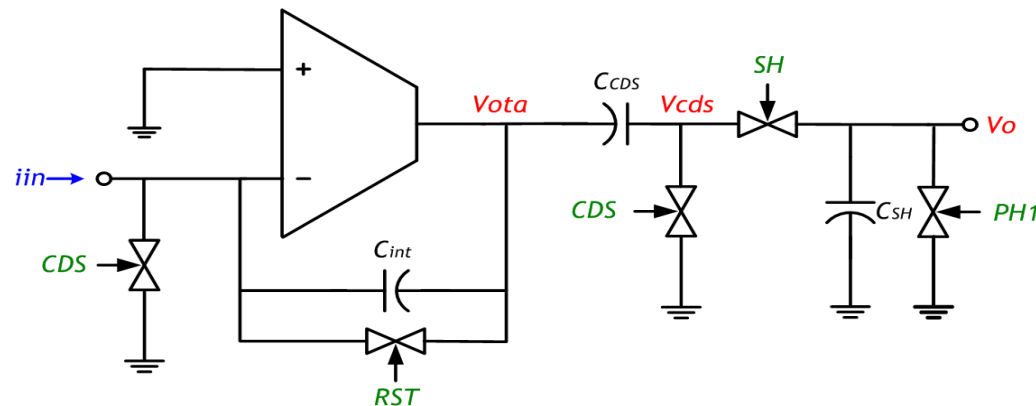


Fully Differential Readout Channel

Differential Correlated Double Sampling Capacitive Trans-impedance Amplifier (1)



- Things to worry about
 - Thermal noise (RTIA)
 - Sampling noise (CTIA)
- Solution
 - Correlated double sampling (CDS) capacitive trans-impedance amplifier





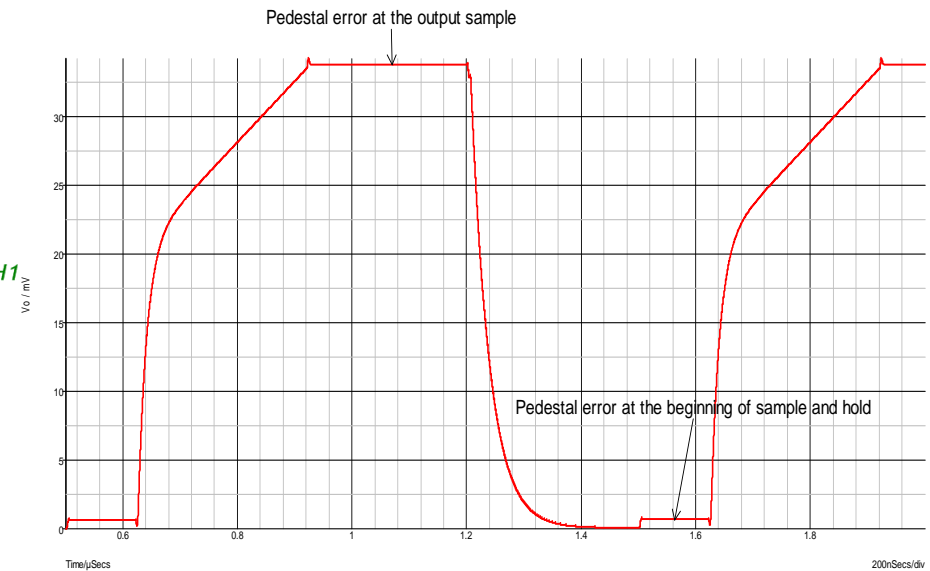
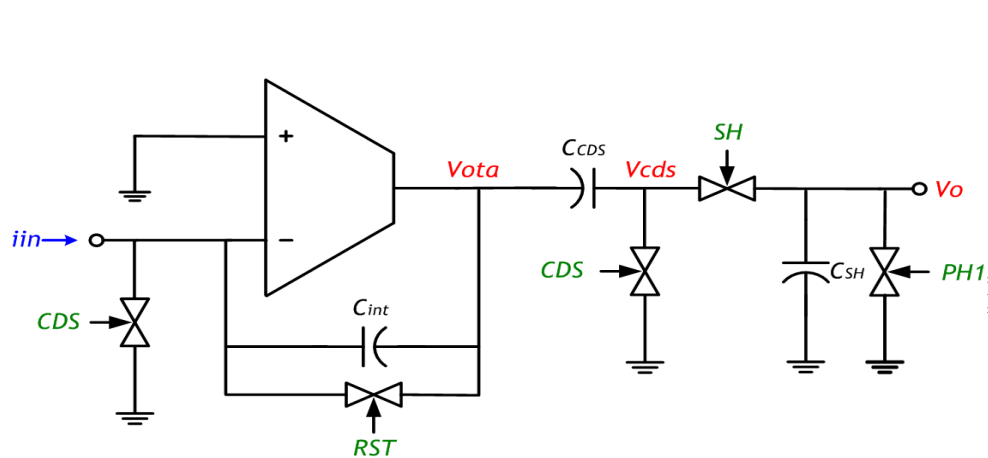
Fully Differential Readout Channel

Differential Correlated Double Sampling

Capacitive Trans-impedance Amplifier (2)



- Single-ended CDS CTIA
 - Charge injection causing pedestal errors



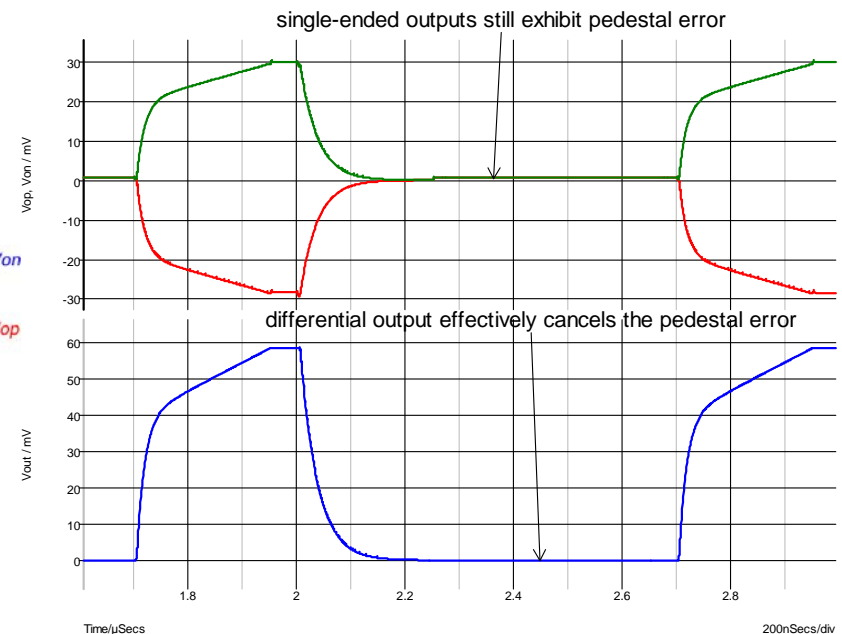
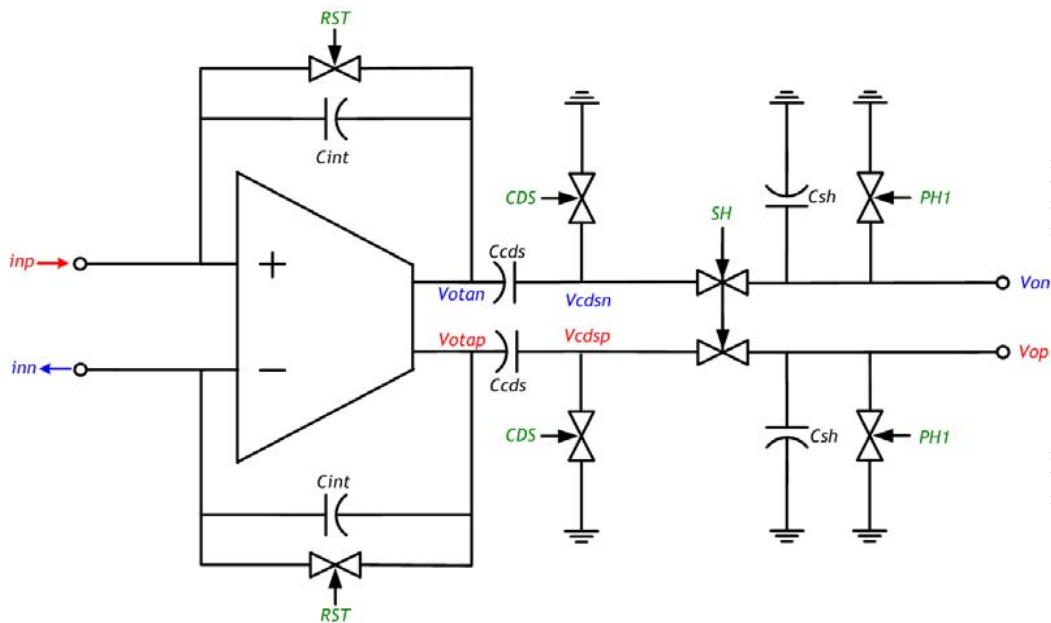


Fully Differential Readout Channel

Differential Correlated Double Sampling Capacitive Trans-impedance Amplifier (2)



- Differential CDS CTIA
 - Charge injection cancellation
 - True and complementary signal integration





Fully Differential Readout Channel

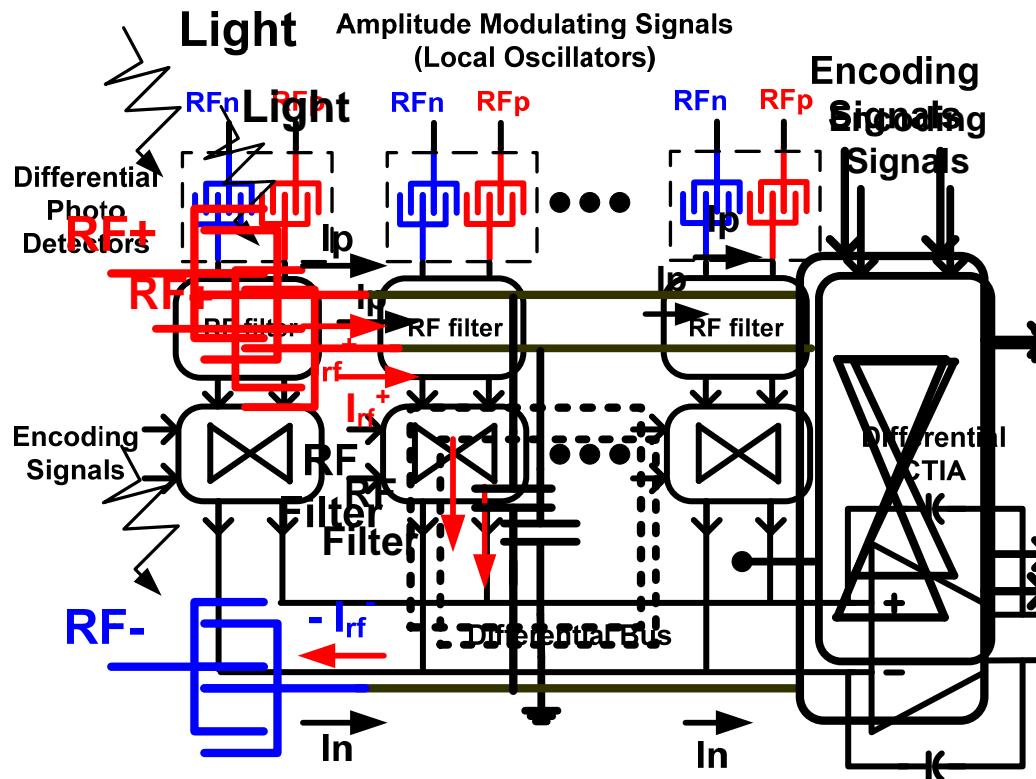
Mitigation of radio frequency
leakage current



- Filter RF before the Encoding cell

Moreover, Differential Shunt Capacitor

- LC-ladder filters
- RC-ladder filters
- Shunt Capacitor





Presentation Outline

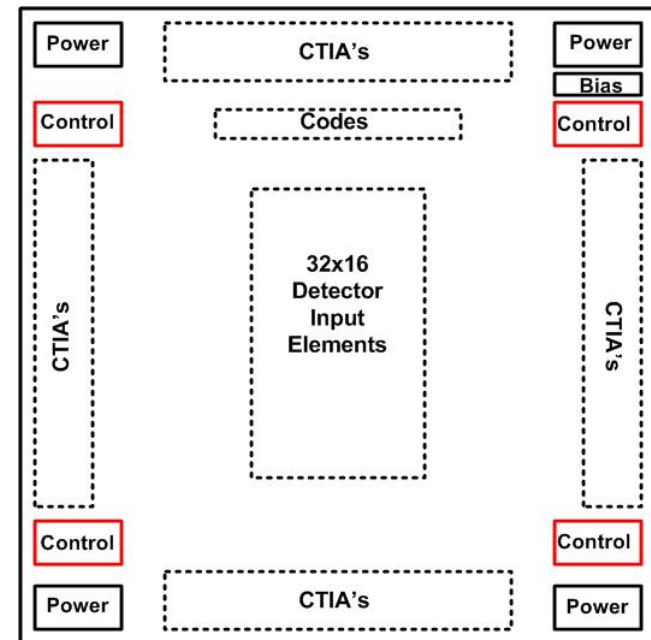
- Introduction
 - Photo-detection for AM/CW LADAR using MSM detectors
 - CDMA ROIC architecture
- Fully Differential Channel
 - Differential MSM photo-detector
 - Differential CDS CTIA
 - Mitigation of RF leakage current
- Design Implementation
 - Floor plan and Layout
 - Post-layout Simulation
- Future work
 - Testing methodology



Design Implementation



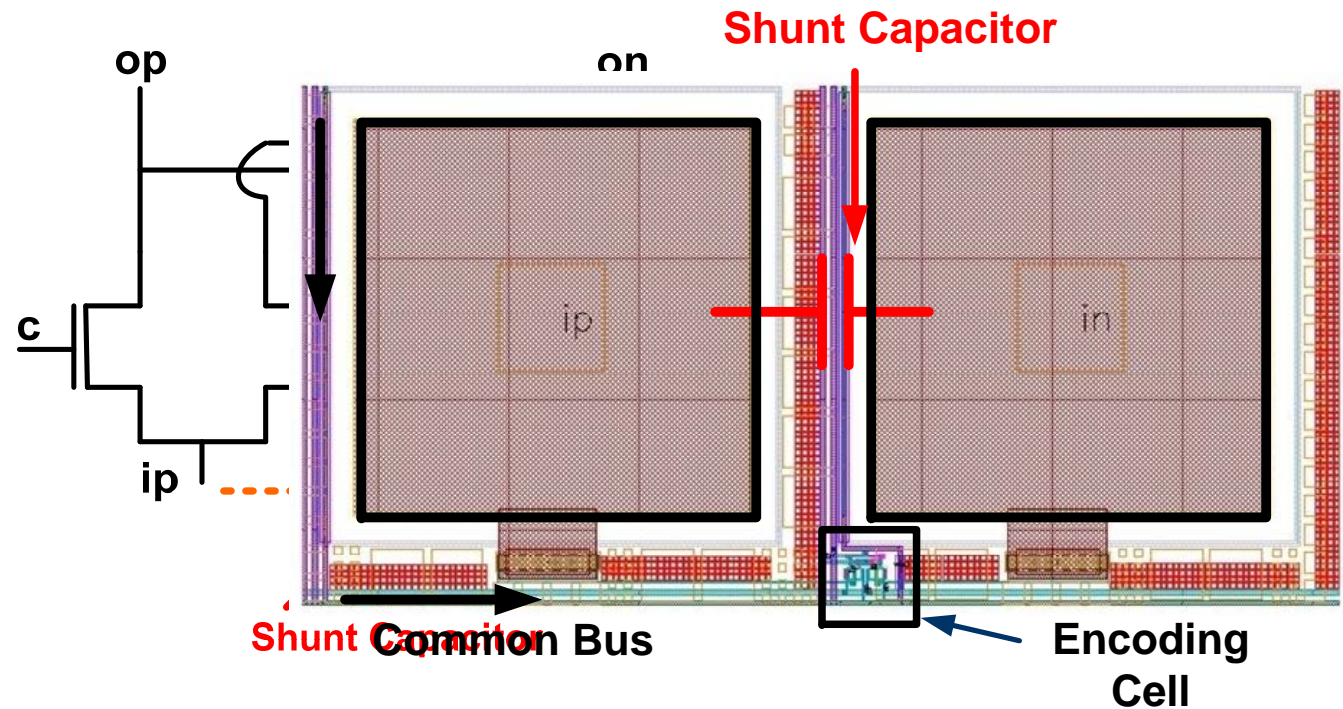
- *0.18 μm CMOS 32x16 Fully Differential ROIC*
 - 32x16 MSM Differential detector
 - 32 CDS CTIA's
 - **Highly Scalable**
 - Special Layout of Components
 - Detector Elements
 - CTIA's





Differential Input Element

- Four transistor encoding cell
 - Differential detector bond pad
 - Parasitic shunt capacitor
- Size*
100 μm height
200 μm width





Design Implementation

Differential Correlated Double Sampling Capacitive Trans-impedance Amplifier



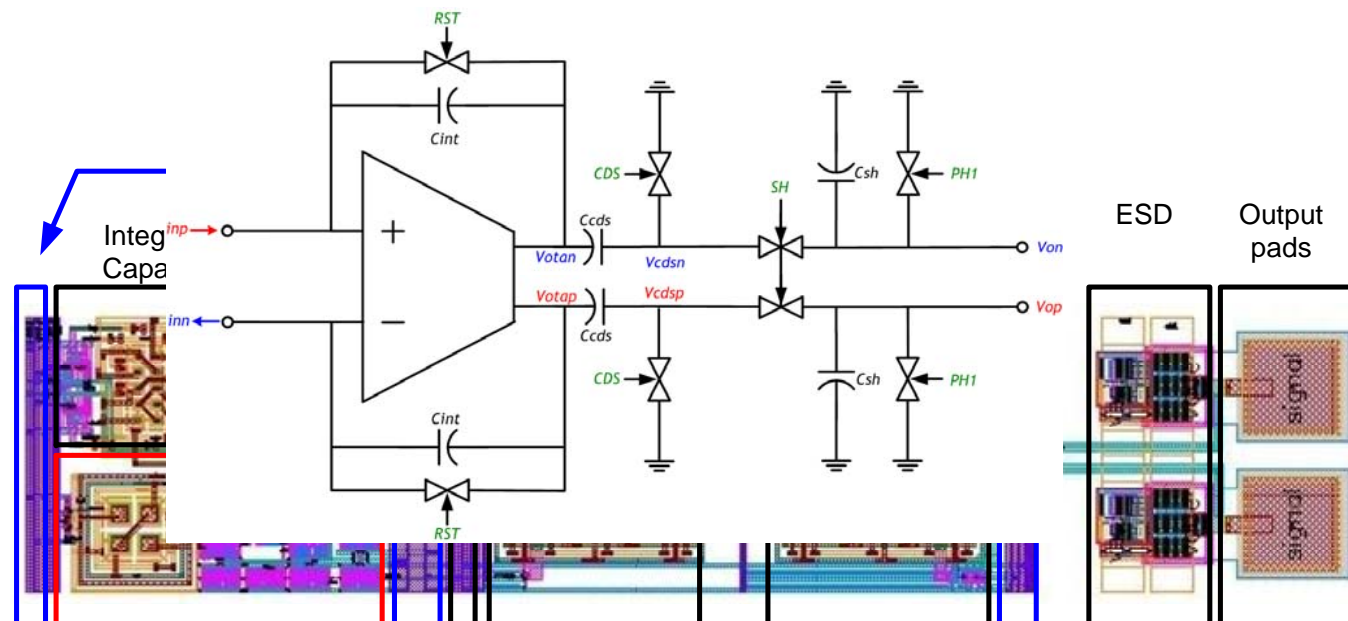
Size

1500 μm length

400 μm height

Four times the height of the detector element

Increases scalability





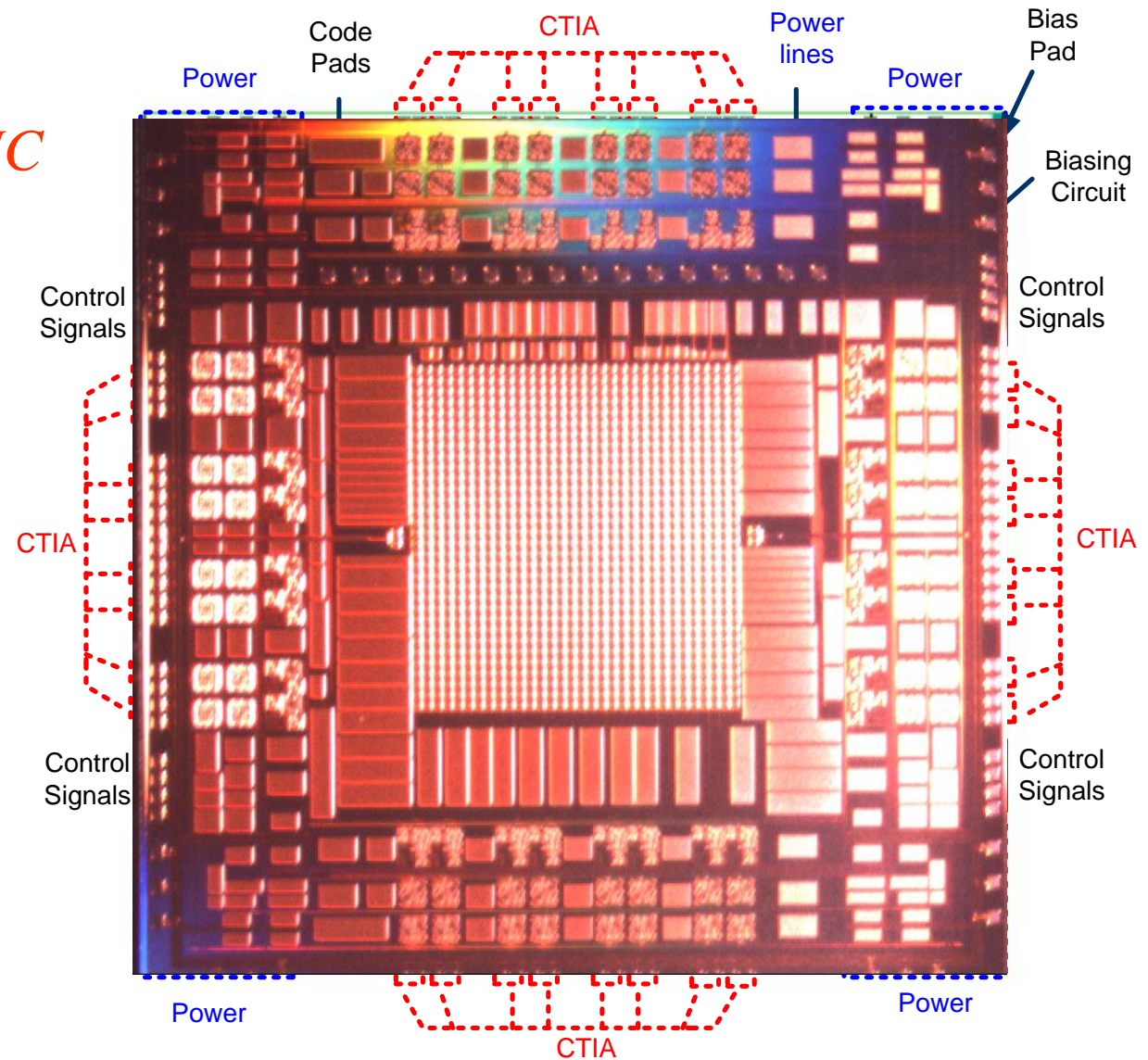
Design Implementation

Full IC Layout



Fabricated Test ROIC

- $8.4 \times 8.4 \text{ mm}^2$
- *Symmetric*
- *Scalable*
 - A 64x32 System





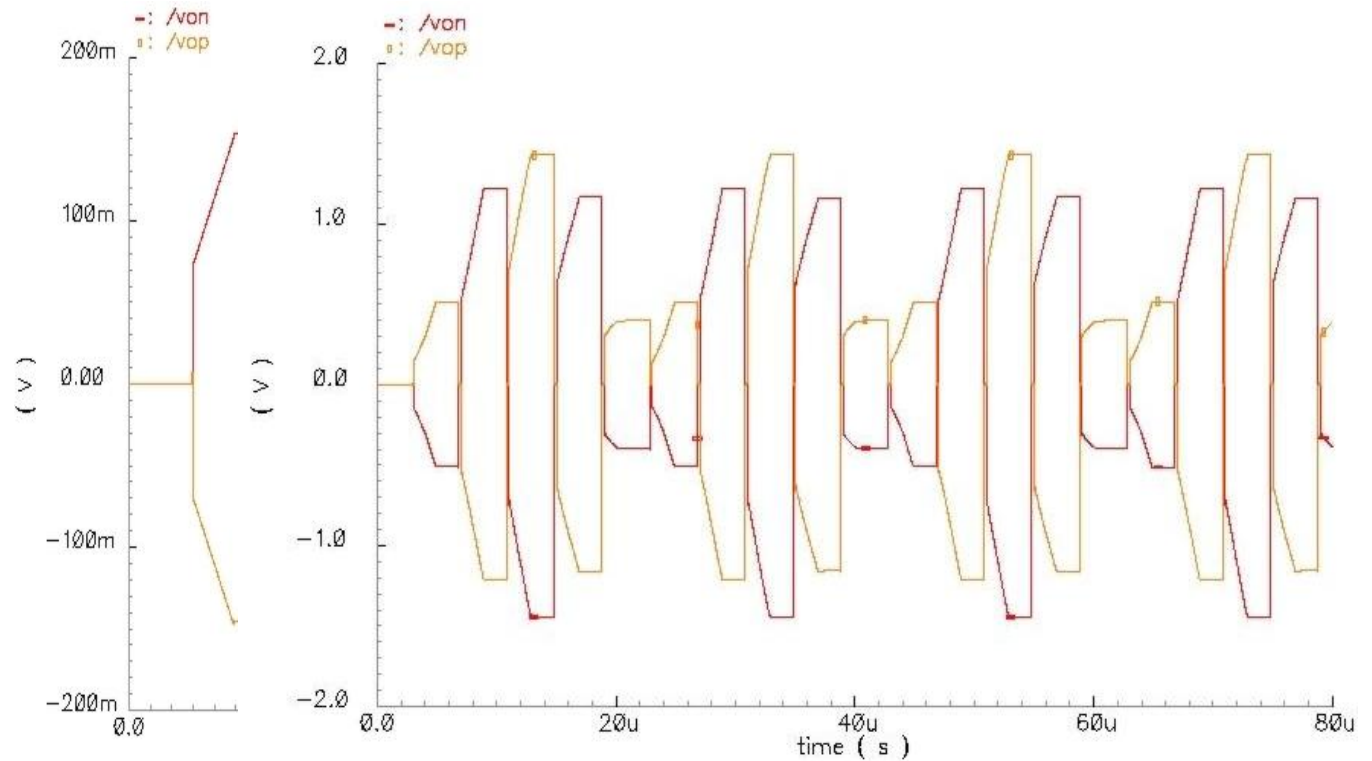
Design Implementation

Post-layout Simulations



DC INPUT CURRENT 25kHZ 50mVpk INPUT CURRENT
NON ENCODED ENCODED @ 1MHz

$$i_{in} = 5nA, i_{ip} = -5nA$$



Sinusoidal Characteristic



Presentation Outline

- Introduction
 - Photo-detection for AM/CW LADAR using MSM detectors
 - CDMA ROIC architecture
- Fully Differential Channel
 - Differential MSM photo-detector
 - Differential CDS CTIA
 - Mitigation of RF leakage current
- Design Implementation
 - Floor plan and Layout
 - Post-layout Simulation
- Future work
 - Testing methodology



Future Work

Testing Methodology

